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U.S. Department of Agriculture
Forest Service
Research Paper SO-144

Developing Stand Risk Classes
for the
Southern Pine Beetle

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Southern
Forest
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SUMMARY

From 1971 through early 1977 in the Kisatchie National Forest, southern pine beetle (SPB) infestations were found to be closely associated with stand and site conditions. Results agreed with those from earlier studies in the lower Coastal Plain and it is suggested that readily available inventory data such as forest type, tree size and age (stand condition class), stand density, and site index can be used to develop a SPB classification system.

Host and site factors that affect the availability and quality of food and habitat for bark beetles can determine the success of brood production and promote or inhibit epidemics of the southern pine beetle (SPB), *Dendroctonus frontalis* Zimm. If the factors that determine SPB risk can be identified, systems can be developed for predicting and eventually controlling bark beetle infestations.

Classification of individual trees to determine the risk of their infestation by bark beetles was successful in the western United States when used in conjunction with selection cutting (Dunning 1928; Keen 1936, 1943; Keen and Salmon 1942; and Salmon and Bongberg 1942). Trees were classed by current symptoms of health. High risk trees were harvested in sanitation cuts to reduce potential loss from the western pine beetle (*Dendroctonus brevicomis* LeConte).

More recent research has clarified the relationship between bark beetles and stands. Amman (1969) reported a direct relationship between phloem depth in lodgepole pine (*Pinus contorta* Dougl.) and mountain pine beetle (*Dendroctonus ponderosae* Hopkins) brood emergence. Most trees with thick phloem were large in diameter and Cole and Amman (1969) suggested that large infestations of mountain pine beetles require the presence of large diameter trees. Cole (1973) suggested that host and environmental characteristics could be used to estimate risk of infestations, brood survival, and probable loss. He and others have applied knowledge of beetle/host/environment relationships to reduce losses to the mountain pine beetle in lodgepole pine stands (Alexander 1972, Safranyik and others 1974, Sartwell and Dolph 1976, Stage 1975, Cole and Cahill 1976).

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Schmid and Frye (1976) developed a rating system for predicting southern pine beetle [*Dendroctonus rufipennis* (Kirby)] outbreaks in stands of Engelmann spruce-subalpine fir [*Picea engelmannii* Parry and Greene], *Abies lasiocarpa* (Hooker, Nuttall)], and Schenk and others (1977) proposed a preliminary fir engraver [*Scolytus ventralis* (LeConte)] hazard rating for grand fir [*Abies grandis* (Dougl.) Lindl.]. Because of recent advances in SPB research related to site and stand conditions, it now is feasible to develop a stand risk classification system based on currently available resource data.

Absence of the SPB in a stand at any time is not an indication of resistance or immunity to attack. The SPB is capable of attacking and killing any of the southern pines, from the smallest sapling to the largest timber. In epidemics, the SPB may be in dense and sparse stands, in and young trees, in all southern pine species, and on a wide range of

In periods when SPB populations are small, they maintain themselves in trees that are highly susceptible to attack but that do not necessarily promote population increases, such as prematurely declining (Lorio 1966, 1973). During endemic periods, the SPB is also likely to be found in large trees. Thick bark, large diameter and longer boles facilitate bark beetle growth and reproduction by providing abundant food room for expansion of the SPB populations.

Some site and stand characteristics potentially useful in classifying stand's risk of SPB infestation have been recognized on lower Gulf Coastal Plain sites in studies in southwest Louisiana and southeast Texas (Lorio and Hodges 1969, 1975; Lorio 1966, 1968, 1973; Lorio and Hodges 1971, 1971; Lorio and others 1972; Lorio and Bennett 1974). Similar relationships are being confirmed on upper Gulf Coastal Plain sites in Louisiana.

Preliminary Studies

As part of a formal study,¹ office records of Catahoula, Evangeline, Kisatchie Ranger Districts of the Kisatchie National Forest were examined for 1971 through 1973. Data were obtained on 228 infestations. Three-fourths of the infestations were in loblolly pine (*Pinus taeda* L.) type stands, 2 percent were in stands over 35 years old. Results were similar for each district. Stand disturbance, such as lightning and wind damage, was associated with 41 percent of the infestations. Lightning alone accounted for 32 percent. Similar results were reported for the lower Coastal Plain in southwest Louisiana, where lightning was associated with 29 percent of all infestations (Lorio and Bennett 1974).

¹ P. L., Jr. Final Report: An appraisal of site and stand characteristics associated with southern pine beetle infestations on the Kisatchie National Forest. FS-SO-310, October 1975.

Field data were collected on 134 infestations in five Ranger Districts (Catahoula, Evangeline, Kisatchie, Winn, and Vernon) from 1972 to 1974. Over three-fourths of the infestations were in loblolly or shortleaf pine type and 72 percent were in stands over 35 years old. Stand disturbance (57 percent) was more frequent than that found in the office records and lightning was associated with 40 percent of the infestations.

Basal area in infested stands averaged 129 ft² per acre (104 ft² in shortleaf pine). Total height averaged 78 feet and d.b.h. averaged 13 inches, (d.b.h. was the arithmetic average for representative dominant and codominant pines). Radial growth for the 10 years prior to infestation averaged 1.2 inches.

Data varied somewhat among districts; the number of infestations studied ranged from 16 in Vernon Ranger District to 42 in Evangeline Ranger District, but results were similar across the forest. Data also seemed to parallel closely those for Hardin County, Texas (Lorio 1968) and Allen Parish, Louisiana (Lorio and Bennett 1974). Southern pine beetles appeared to be recurring in well-stocked to overstocked loblolly or shortleaf pine sawtimber stands over 35 years old. Moreover, infestations appeared to occur in stands where tree growth was declining. But before a stand risk classification could be attempted, data were needed on the nature of existing resources, on whether the sample measured was representative of the infested forest, and on the frequency and size of SPB infestations.

Stand- and Site-Infestation Relationships

The timber management plan for the Kisatchie National Forest (FY 1972 through 1981) reported a total area of 593,373 acres, of which 571,654 acres were classed as forest land, and 552,123 acres as commercial forest land. The forest was predominantly pine—about 93 percent pine and hard-wood-pine types. Loblolly pine was the primary species but there was also considerable acreage of longleaf (*P. palustris* Mill.), shortleaf (*P. echinata* Mill.), and slash pine (*P. elliottii* Engelm. var. *elliottii*). About 43 percent of the forest was in age classes under 35 years, 46 percent over 35 years, and 11 percent unclassified. Prevailing site index at age 50 for loblolly pine was 90 (ranging from 60 to 120).

SPB activity was low in early 1971, but increased through the fall and winter, and was given epidemic status in 1972 (Kucera and Nachod 1972). In 1973 and 1974, salvage records showing SPB occurrence on the forest were not available, so we cannot tell what proportion of the total number of infestations were studied. Also samples studied may not have been representative of the general distribution of infestations.

The advent of the Expanded Southern Pine Beetle Research and Applications Program allowed a more thorough evaluation of the forest re-

es available to the SPB compared to that portion being attacked? All SPB activity on National Forest land could now be monitored. Data collection began in June 1975 and assessment of 1396 infestations through the first 22 months of the study supports relationships noted in earlier studies.

Examination of the Continuous Inventory of Stand Conditions (CISC) as of June 1976 showed that the regulated commercial forest acreage divided among stand condition classes as follows: 47 percent immature and mature sawtimber (11.0 inches d.b.h. minimum), 20 percent poletimber (5.0 to 10.9 inches d.b.h.), 21 percent seedling and sapling, and 6 percent in regeneration (table 1). The remainder was mostly in sparse and low quality sawtimber. Pine types comprised 87 percent (loblolly 52 percent, longleaf 19 percent, slash 9 percent, and shortleaf 7 percent), hardwood pine types 6 percent, and hardwood types 7 percent of the forest. About 43 percent of the area in loblolly pine type was in mature (60 years or older) or immature sawtimber and 19 percent in immature poletimber.

A disproportionate number of infestations occurred in sawtimber stands of all forest types, and in loblolly pine type (table 1). Frequency of infestations across stand condition classes differed significantly at the 0.05 probability level from distributions that might be expected considering the areas occupied by each stand condition class. About 69 percent of infestations were in sawtimber stands; of those that occurred in loblolly pine type, 67 percent were in sawtimber. Infestation frequency in immature poletimber was proportional to the area occupied by that stand condition class.

Fifty-nine percent of the infestations recorded were associated with a kind of stand disturbance considered serious enough to induce bark beetle attacks (37 percent lightning, 11 percent wind, and 11 percent

lightning). Fifty-five percent of all infestations and 84 percent of infestations in loblolly pine type were in stands 35 years and older. Culmination of the current mean annual increment (MAI) of loblolly pine is around 30 to 35 years and culmination of the board-foot MAI is about 40 to 45 years (Foster 1966). Culmination of the current annual increment (CAI) precedes MAI by several years. Safranyik and others (1974) indicated that southern pine beetle infestations in loblolly pine tend to occur more frequently as the CAI declines and intensify after culmination of the MAI. A similar relationship seems to exist between the SPB and loblolly pine in

Table 1.—Regulated commercial forest area and SPB infestations by stand condition class and forest type on the Kisatchie National Forest (June 1976 CISC data).

Stand Condition Class	All Forest Types ¹			Loblolly Pine Type ²		
	Area (Acres)	Percent of Total	Number of Infestations	Area (Acres)	Percent of Total	Number of Infestations
Mature sawtimber	55,193	10.55	234	16.76	34.036	12.42
Immature sawtimber	191,921	36.67	735	52.65	82.596	30.14
Immature poletimber	106,739	20.39	255	18.27	52.426	19.13
In regeneration	30,542	5.83	24	1.72	20.236	7.38
Seedling and sapling ³	110,619	21.14	90	6.45	76.398	27.87
All others	28,369	5.42	58	4.15	8.382	3.06
Totals	523,383	100.00	1396	100.00	274,074	100.00
						936
						100.00

¹Chi-square = 390.7, significant at the 0.01 level.

²Chi-square = 367.5, significant at the 0.01 level.

³Adequately and inadequately stocked combined.

beetle problems become evident around age 30 and intensify with age until through culmination of the board-foot MAI. Eighty-one percent of all infestations were on moist, wet, or watered sites. Seventy-two percent were on moist sites that are closely associated with high site index. This distribution agrees with the high age site index (97 feet at age 50 for loblolly pine) found in a sample of 7 infestations where no disturbance such as lightning was observed. This sample, pine stands averaged 42 years old, 123 ft² of basal area per (100 ft² of pine), 110 pines per acre and 12.9 inches d.b.h. The study continuing but these data and those from earlier studies suggest that beetle activity is closely associated with recognizable stand and site conditions that can be used to predict possible outbreaks, aid detection surveys, and influence stand selection for regeneration and intermediate cuts.

Implications

Results of recent and current studies confirm results and interpretations of previous studies in the Gulf Coastal Plain (Lorio 1968, Lorio and Amman 1974). SPB infestations tend to recur in stands that represent a food supply and habitat for bark beetle reproduction; that is, in sawer stands that are near or beyond culmination of the MAI and are good to excellent sites. These relationships can be used to develop a risk classification system for SPB infestation. Forest managers and control specialists need such a means of considering potential losses from beetles in making decisions about which stands to thin, which to regenerate, how many, and whether or not a bark beetle control program is justified.

The stand classification system should consider (1) relative susceptibility or resistance of stands to beetle attack, (2) potential for SPB reproduction, and (3) potential loss of resource in the event of successful attacks. One approach based on the use of readily available CISC data is being developed and tested on the Kisatchie National Forest.³ The resource factors being used are forest type, stand condition class (size and age), index, operability⁴ and method of cut. Operability and method of cut are being used as broad indicators of stand density because basal area is currently available in CISC.

Since we cannot predict SPB activity, we are asking where outbreaks may be expected to develop, and if they do, where resource losses and

³ P. L. Jr. and S. Zarnoch. Study Plan: Stand hazard classification for the mountain pine beetle. FS-SO-2203-6.13, March 1977.

⁴ Operable pine pole timber stands must yield at least 3 cords per acre under a culturally acceptable method of cut, and sawtimber stands at least 800 board feet acre (Scribner rule).

beetle reproduction are likely to be greatest. If currently available routine forest inventory data can be used to estimate bark beetle risk, plans to deal with potential bark beetle problems can be easily incorporated into overall planning systems.

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Southern pine beetle infestations tend to recur in sawtimber stands that are near or beyond culmination of the mean annual increment and are on good to excellent sites. Readily available forest inventory data such as forest type, tree size and age (stand condition class), stand density, and site index can be used to develop a southern pine beetle risk classification system.

Additional keywords: *Dendroctonus frontalis*, hazard rating, site, food source, habitat.